A

CENTURY

OF THE

NAMES AND SCANTLINGS

OF SUCH

INVENTIONS,

As at preſent I can call to mind to have tried and perfected, which (my former Notes being loſt) I have, at the inſtance of a powerful Friend, endeavoured now in the Year 1655, to ſet theſe down in ſuch a way as may ſufficiently inſtruct me to put any of them in practice.

——*Artis et naturae proles.*

THE AUTHOR THE

MARQUIS OF WORCESTER.

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BRITISH MUSEUM
15
GB

KING'S

MOST

EXCELLENT MAJESTY

SIR,

'SCIRE meum nihil eſt, niſi me 'ſcire hoc ſciat alter,' ſaith the poet, and I moſt juſtly in order to your Majeſty, whoſe ſatisfaction is my happineſs, and whom to ſerve is my only aim, placing therein my *ſummum bonum* in this world: Be therefore pleaſed to caſt your gracious eye over this ſummary collection, and then to pick and chooſe, I confeſs, I made it but for the ſuperficial ſatisfaction of a friend's curioſity, ac-

cording as it is ſet down; and if it might now ſerve to give aim to your Majeſty how to make uſe of my poor endeavours, it would crown my thoughts, who am neither covetous nor ambitious, but of deſerving your Majeſty's favour upon my own coſt and charges; yet according to the old Engliſh proverb, it is a poor dog not worth whiſtling after. Let but your Majeſty approve and I will effectually perform to the height of my undertaking: vouchſafe but to command, and with my life and fortune I ſhall chearfully obey, and maugre envy, ignorance and malice, ever appear.

YOUR MAJESTY's

Paſſionately-devoted, or otherwiſe diſintereſted Subject and Servant,

WORCESTER.

TO THE

RIGHT HONOURABLE

THE LORDS

SPIRITUAL AND

TEMPORAL;

And to the KNIGHTS, CITIZENS and BURGESSES of the Honourable Houſe of Commons, now aſſembled in Parliament.

MY LORDS AND GENTLEMEN,

BE not ſtartled if I addreſs to all, and every of you, this century of ſummary heads of wonderful things, even after the dedication of them to his moſt excellent Majeſty,

ſince it is with his moſt gracious and particular conſent, as well as indeed no ways derogating from my duty to his ſacred ſelf, but rather in further order unto it, ſince your Lordſhips, who are his great council, and you Gentlemen his whole kingdom's repreſentatives (moſt worthily welcome unto him) may fitly receive into your wiſe and ſerious conſiderations what doth or may publicly concern both his Majeſty and his tenderly-beloved people.

Pardon me if I ſay (my Lords and Gentlemen) that it is jointly your parts to digeſt to his hand theſe enſuing particulars, fitting them to his palate, and ordering how to reduce them into practice in a way uſeful and beneficial both to his Majeſty and his Kingdom.

Neither do I eſteem it leſs pro-

per for me to preſent them to you in order to his Majeſty's ſervice, than it is to give into the hands of a faithful and provident ſteward whatſoever dainties and proviſions are intended for the maſter's diet; the knowing and faithful ſteward being beſt able to make uſe thereof to his maſter's contentment and greateſt profit, keeping for the morrow whatever ſhould be overplus or needleſs for the preſent day, or at leaſt to ſave ſomething elſe in lieu thereof. In a word, (my Lords and Gentlemen) I humbly conceive this ſimile not improper, ſince you are his Majeſty's provident ſtewards, into whoſe hands I commit myſelf, with all properties fit to obey you; that is to ſay, with a heart harbouring no ambition, but an endleſs aim to ſerve my king and country: and if my endeavours

prove effectual, (as I am confident they will) his Majeſty ſhall not only become rich, but his people likewiſe, as treaſurers unto him; and his peerleſs Majeſty, our King, ſhall become both beloved at home, and feared abroad; deeming the riches of a king to conſiſt in the plenty enjoyed by his people.

And the way to render him to be feared abroad, is to content his people at home, who then with heart and hand are ready to aſſiſt him: and whatſoever God bleſſeth me with, to contribute towards the increaſe of his revenues in any conſiderable way, I deſire it may be employed to the uſe of his people; that is, for the taking off ſuch taxes or burthens from them as they chiefly groan under, and by a temporary neceſſity only impoſed on them; which being

thus ſupplied will certainly beſt content the King, and ſatisfy his people; which I dare ſay, is the continual tend of all your indefatigable pains, and the perfect demonſtrations of your zeal to his Majeſty, and an evidence that the kingdom's truſt is juſtly and deſervedly repoſed in you. And if ever Parliament acquitted themſelves thereof, it is this of yours, compoſed of moſt deſerving and qualified perſons; qualified, I ſay, with your affection to your Prince, and with a tenderneſs to his people; with a bountiful heart towards him, yet a frugality in their behalfs.

Go on therefore chearfully (my Lords and Gentlemen) and not only our gracious King, but the King of Kings, will reward you, the prayers of the people will attend you, and his Majeſty will with thankful

arms embrace you. And be pleaſed to make uſe of me and my endeavours to enrich them, not myſelf; ſuch being my only requeſt unto you, ſpare me not in what your wiſdoms ſhall find me uſeful, who do eſteem myſelf not only by the act of the water-commanding engine (which ſo chearfully you have paſt) ſufficiently rewarded, but likewiſe with courage enabled me to do ten times more for the future; and my debts being paid, and a competency to live according to my birth and quality ſettled, the reſt ſhall I dedicate to the ſervice of our King and country by our diſpoſals: and eſteem me not the more, or rather any more, by what is paſt, but what's to come; profeſſing really from my heart, that my intentions are to out-go the ſix or ſeven hundred thouſand pounds already ſacrifi-

ced, if countenanced and encouraged by you, ingenuouſly confeſſing, that the melancholy which hath lately ſeized upon me (the cauſe whereof none of you but may eaſily gueſs) hath, I dare ſay, retarded more advantages to the public ſervice than modeſtly will permit me to utter: and now revived by your promiſing favours, I ſhall infallibly be enabled thereunto in the experiments extant, and compriſed under theſe heads practicable with my directions by the unparalleled workman, both for truſt and ſkill, Caſpar Kaltoff's hand, who hath been theſe five and thirty years as in a ſchool under me employed, and ſtill at my diſpoſal, in a place by my great expences made fit for public ſervice, yet lately like to be taken from me, and conſequently from the ſervice of King and kingdom

without the leaſt regard of above ten thouſand pounds expended by me, and through my zeal to the common good; my zeal, I ſay, a field large enough for you (my Lords and Gentlemen) to work upon.

The treaſures buried under theſe heads, both for war, peace and pleaſure, being inexhauſtible; I beſeech you pardon me if I ſay ſo; it ſeems a vanity, but comprehends a truth; ſince no good ſpring but becomes the more plentiful by how much more it is drawn; and the ſpinner to weave his web is never ſtinted but further enforced. The more then that you ſhall be pleaſed to make uſe of my inventions, the more inventive ſhall you ever find me, one invention begetting ſtill another, and more and more improving my ability to ſerve my King and you; and as to my heartineſs

therein there needs no addition, nor to my readineſs a ſpur. And therefore (my Lords and Gentlemen) be pleaſed to begin, and deſiſt not from commanding me till I flag in my obedience and endeavours to ſerve my King and country.

For certainly you'll find me breathleſs firſt t' expire,
Before my hands grow weary, or my legs do tire.

Yet abſtracting from any intereſt of my own, but as a fellow-ſubject and compatriot will I ever labour in the vineyard, moſt heartily and readily obeying the leaſt ſummons from you by putting faithfully in execution, what your judgements ſhall think fit to pitch upon amongſt this century of experiences, perhaps dearly purchaſed by me, but now frankly and *gratis* offered to you. Since my heart

(methinks) cannot be ſatisfied in ſerving my King and country, if it should coſt them any thing; as I confeſs when I had the honour to be near ſo obliging a maſter as his late Majeſty, of happy memory, who never refuſed me his ear to any reaſonable motion: and as for unreaſonable ones, or ſuch as were not fitting for him to grant, I would rather have died a thouſand deaths, than ever to have made any one unto him.

Yet whatever I was ſo happy as to obtain for any deſerving perſon, my pains, breath and intereſt employed therein ſatisfied me not, unleſs I likewiſe ſatisfied the fees; but that was in my golden age.

And even now, though my ability and means are ſhortened, the world knows why my heart remains ſtill the ſame; and be you pleaſed (my Lords

and Gentlemen) to reſt moſt aſſured, that the very complacency that I ſhall take in the executing your commands ſhall be unto me a ſufficient and an abundantly ſatisfactory reward.

Vouchſafe therefore to diſpoſe freely of me, and whatever lieth in my power to perform; firſt, in order to his Majeſty's ſervice; ſecondly, for the good and advantage of the Kingdom; thirdly, to all your ſatisfactions, for particular profit and pleaſure to your individual ſelves, profeſſing that in all and each of the three reſpects I will ever demean myſelf as it beſt becomes,

My Lords and Gentlemen,

Your moſt paſſionately-bent Fellow-Subject in his Majeſty's ſervice, Compatriot for the public good and advantage, and a moſt humble Servant to all and every of you,

WORCESTER.

A CENTURY OF THE NAMES AND SCANTLINGS OF INVENTIONS BY ME ALREADY PRACTISED.

I. SEVERAL ſorts of ſeals, ſome ſhewing by ſcrews, others by gages faſtening or unfaſtening all the marks at once; others by additional points and imaginary places, proportionable to ordinary eſcutcheons and ſeals at arms, each way palpably and punctually ſetting down (yet private

from all others, but the owner, and by his aſſent) the day of the month, the day of the week, the month of the year, the year of our Lord, the names of the witneſſes, and the individual place where any thing was ſealed, though in ten thouſand ſeveral places, together with the very number of lines contained in a contract, whereby falſification may be diſcovered, and manifeſtly proved, being upon good grounds ſuſpected.

Upon any of theſe ſeals a man may keep accounts of receipts and diſburſments from one farthing to an hundred millions, punctually ſhewing each pound, ſhilling, penny or farthing.

By theſe ſeals likewiſe any letter, though written but in Engliſh, may be read and underſtood in eight ſeveral languages, and in Engliſh it-

ſelf to clean contrary and different ſenſe, unknown to any but the correſpondent, and not to be read or underſtood by him neither, if opened before it arrive unto him; ſo that neither threats, nor hopes of reward, can make him reveal the ſecret, the Letter having been intercepted, and firſt opened by the enemy.

II. How ten thouſand perſons may uſe theſe ſeals to all and every of the purpoſes aforeſaid, and yet keep their ſecrets from any but whom they pleaſe.

III. A cypher and character ſo contrived, that one line, without returns and circumflexes, ſtands for each and every of the 24 letters; and as ready to be made for the one letter as the other.

IV. This invention refined, and ſo abbreviated that a point only ſheweth

diſtinctly and ſignificantly any of the 24 letters; and theſe very points to be made with two pens, ſo that no time will be loſt, but as one finger riſeth the other may make the following letter, never clogging the memory with ſeveral figures for words, and combination of letters; which with eaſe, and void of confuſion, are thus ſpeedily and punctually, letter for letter, ſet down by naked and not multiplied points. And nothing can be leſs than a point, the mathematical defination of being *Cujus pars nulla*. And of a motion no ſwifter imaginable than Semiquavers or reliſhes, yet applicable to this manner of writing.

V. A way by circular motion, either along a rule or ring wiſe, to vary any alphabet, even this of points, ſo that the ſelf ſame point individu-

ally placed without the leaſt additional mark or variation of place, ſhall ſtand for all the 24 letters, and not for the ſame letter twice in ten ſheets writing; yet as eaſily and certainly read and known, as if it ſtood but for one and the ſelf-ſame letter conſtantly ſignified.

VI. How at a window, as far as eye can diſcover black from white, a man may hold diſcourſe with his correſpondent, without noiſe made or notice taken; being, according to occaſion given and means afforded, *Ex re nata*, and no need of proviſion before hand; though much better if foreſeen and means prepared for it, and a premeditated courſe taken by mutual conſent of parties.

VII. A way to do it by night as well as by day, though as dark as pitch is black.

VIII. A way how to level and ſhoot cannon by night as well as by day, and as directly; without a platform or meaſures taken by day, yet by a plain and infallible rule.

IX. An engine, portable in ones pocket, which may be carried and faſtened on the inſide of the greateſt ſhip, *Tanquam aliud agens*, and at any appointed minute, though a week after, either of day or night, it ſhall irrecoverably ſink that ſhip.

X. A way from a mile off to dive and faſten a like engine to any ſhip, ſo as it may punctually work the ſame effect either for time or execution.

XI. How to prevent and ſafeguard any ſhip from ſuch an attempt by day or night.

XII. A way to make a ſhip not poſſible to be ſunk though ſhot an hundred times betwixt wind and wa-

ter by cannon, and ſhould loſe a whole plank, yet in half an hours time ſhould be made as fit to ſail as before.

XIII. How to make ſuch falſe decks as in a moment ſhould kill and take priſoners as many as ſhould board the ſhip, without blowing the decks up, or deſtroying them from being reducible, and in a quarter of an hour's time ſhould recover their former ſhape, and to be made fit for any employment without diſcovering the ſecret.

XIV. How to bring a force to weigh up an Anchor, or to do any forcible exploit in the narroweſt or loweſt room in any ſhip, where few hands ſhall do the work of many; and many hands applicable to the ſame force, ſome ſtanding, others ſitting, and by virtue of their ſeveral helps a

great force augmented in little room, as effectual as if there were ſufficient ſpace to go about with an axle-tree, and work far from the centre.

XV. A way how to make a boat work itſelf againſt wind and tide, yea both without the help of man or beaſt; yet ſo that the wind or tide, though directly oppoſite, ſhall force the ſhip or boat againſt itſelf and in no point of the compaſs, but it ſhall be as effectual, as if the wind were in the pupp, or the ſtream actually with the courſe it is to ſteer, according to which the oars ſhall row, and neceſſary motions work and move towards the deſired port or point of the compaſs.

XVI. How to make a ſea-caſtle or fortification cannon-proof, and capable of a thouſand men, yet ſailable at pleaſure to defend a paſſage, or in

an hour's time to divide itſelf into three ſhips as fit and trimmed to ſail as before: and even whilſt it is a fort or caſtle they ſhall be unanimouſly ſteered, and effectually be driven by an indifferent ſtrong wind.

XVII. How to make upon the Thames a floating garden of pleaſure, with trees, flowers, banqueting-houſes, and fountains, ſtews for all kind of fiſhes, a reſerve for ſnow to keep wine in, delicate bathing-places, and the like; with muſic made with mills: and all in the midſt of the ſtream, where it is moſt rapid.

XVIII. An artificial fountain to be turned like an hour-glaſs by a child in the twinkling of an eye, it holding great quantity of water, and of force ſufficient to make ſnow, ice and thunder, with a chirping and ſinging of birds, and ſhewing of ſe-

veral ſhapes and effects uſual to fountains of pleaſure.

XIX. A little engine within a coach, whereby a child may ſtop it, and ſecure all perſons within it, and the coach-man himſelf, though the horſes be never ſo unrully in a full career; a child being ſufficiently capable to looſen them in what poſture ſoever they ſhould have put themſelves, turning never ſo ſhort; for a child can do it in the twinkling of an eye.

XX. How to bring up water balance-wiſe, ſo that as little weight or force as will turn a balance will be only needful, more than the weight of the water within the buckets, which counterpoiſed empty themſelves one into the other, the uppermoſt yielding its water (how great a quantity ſoever it holds) at the ſelf-ſame time the lowermoſt tak-

eth it in, though it be an hundred fathom high.

XXI. How to raiſe water conſtantly with two buckets only day and night, without any other force, than its own motion, uſing not ſo much as any force wheel or ſucker, nor more pullies than one, on which the cord or chain rolleth with a bucket faſtened at each end. This I confeſs, I have ſeen and learned of the great mathematician Claudius his ſtudies at Rome, he having made a preſent thereof unto a Cardinal; and I deſire not to own any other mens inventions, but if I ſet down any, to nominate likewiſe the inventor.

XXII. To make a river in a garden to ebb and flow conſtantly, though twenty feet over, with a child's force, in ſome private room or

place out of ſight, and a competent diſtance from it.

XXIII. To ſet a clock in a caſtle, the water filling the trenches about it; it ſhall ſhew by ebbing and flowing the hours, minutes and ſeconds, and all the comprehenſible motions of the heavens, and counter liberation of the earth, according to Copernicus.

XXIV. How to increaſe the ſtrength of a ſpring to ſuch an height, as to ſhoot bumbaſſes, and bullets of an hundred pound weight a ſteeple height, and a quarter of a mile off and more, ſtone-bow-wiſe, admirable for fire-works and aſtoniſhing of beſieged cities, when without warning given by noiſe they find themſelves ſo forcibly and dangerouſly ſurpriſed.

XXV. How to make a weight

that cannot take up an hundred pound, and yet ſhall take up two hundred pound, and at the ſelf-ſame diſtance from the centre; and ſo proportionably to millions of pounds.

XXVI. To raiſe weight as well and as forcibly with the drawing back of the lever, as with the thruſting it forwards; and by that means to loſe no time in motion or ſtrength. This I ſaw in the Arſenal at Venice.

XXVII. A way to remove to and fro huge weights with a moſt inconſiderable ſtrength from place to place. For example, ten ton with ten pounds, and leſs; the ſaid ten pounds not to fall lower than it makes the ten ton to advance or retreat upon a level.

XXVIII. A bridge portable in a cart with ſix horſes, which in a few hours time may be placed over a river half a mile broad, whereon with

much expedition may be tranſported horſe, foot and cannon.

XXIX. A portable fortification able to contain five hundred fighting men, and yet in ſix hours time may be ſet up, and made cannon-proof, upon the ſide of a river or paſs, with cannon mounted upon it, and as complete as a regular fortification, with half-moons and counter-ſcarps.

XXX. A way in one night's time to raiſe a bulwark twenty or thirty feet high, cannon-proof, and cannon mounted upon it, with men to overlook command and batter a town; for though it contain but four pieces, they ſhall be able to diſcharge two hundred bullets each hour.

XXXI. A way how ſafely and ſpeedily to make an approach to a caſtle or town-wall, and over the very ditch, at noon day.

XXXII. How to compoſe an univerſal character, methodical and eaſy to be written, yet intelligible in any language; ſo that if an Engliſh-man write it in Engliſh, a French-man, Italian, Spaniard, Iriſh, Welſh, being Scholars; yea, Grecian or Hebrean ſhall as perfectly underſtand it in their own tongue, as if they were perfect Engliſh, diſtinguiſhing the verbs from nouns, the numbers, tenſes and caſes as properly expreſſed in their own language as it was written in Engliſh.

XXXIII. To write with a needle and thread, white, or any colour upon white, or any other colour, ſo that one ſtitch ſhall ſignificantly ſhew any letter, and as readily and as eaſily ſhew the one letter as the other, and fit for any language.

XXXIV. To write by a knotted ſilk ſtring, ſo that every knot ſhall ſig-

nify any letter, with comma, full point, or interrogation, and as legible as with pen and ink upon white paper.

XXXV. The like by the fringe of gloves.

XXXVI. By ſtringing of bracelets.

XXXVII. By pinck'd gloves.

XXXVIII. By holes in the bottom of a ſieve.

XXXIX. By a lattin or plate lanthorn.

XL. By the ſmell.
XLI. By the taſte.
XLII. By the touch.

By theſe three ſenſes as perfectly, diſtinctly and unconfuſedly, yea as readily as by the ſight.

XLIII. How to vary each of theſe, ſo that ten thouſand may know them, and yet keep the underſtanding part from any but their correſpondent.

XLIV. To make a key of a cham-

ber door, which to your ſight, hath its wards and roſe-pipe, but paper-thick, and yet at pleaſure, in a minute of an hour, ſhall become a perfect piſtol, capable to ſhoot through a breaſt-plate commonly of Carabine-proof with prime, powder and fire-lock, undiſcoverable in a ſtranger's hand.

XLV. How to light a fire and a candle at what hour of the night one awaketh, without riſing or putting one's hand out of the bed. And the ſame thing becomes a ſerviceable piſtol at pleaſure; yet by a ſtranger, not knowing the ſecret, ſeemeth but a dextrous tinder-box.

XLVI. How to make an artificial bird to fly which way and as long as one pleaſeth, by or againſt the wind, ſometimes chirping, other times hovering, ſtill tending the way it is deſigned for.

XLVII. To make a ball of any metal, which thrown into a pool or pail of water ſhall preſently riſe from the bottom, and conſtantly ſhew by the ſuperficies of the water the hour of the day or night, never riſing more out of the water than juſt to the minute it ſheweth of each quarter of the hour; and if by force kept under water, yet the time is not loſt, but recovered as ſoon as it is permitted to riſe to the ſuperficies of the water.

XLVIII. A ſcrewed aſcent, inſtead of ſtairs, with fit landing places to the beſt chambers of each ſtory, with back-ſtairs within the newel of it, convenient for ſervants to paſs up and down to the inward rooms of them unſeen and private.

XLIX. A portable engine, in way of a tobacco-tongs, whereby a man

may get over a wall, or get up again, being come down, finding the coaſt proving unſecure unto him.

L. A complete light portable ladder, which taken out of one's pocket, may be by himſelf faſtened an hundred feet high to get up by from the ground.

LI. A rule of gradation, which with eaſe and method reduceth all things to a private correſpondence, moſt uſeful for ſecret intelligence.

LII. How to ſignify words and a perfect diſcourſe, by jingling of bells of any pariſh-church, or by any muſical inſtrument within hearing, in a ſeeming way of tuning it; or of an unſkilful beginner.

LIII. A way how to make hollow and cover a Water-ſcrew as big and as long as one pleaſeth in an eaſy and cheap way.

LIV. How to make a water-ſcrew tight, and yet tranſparent, and free from breaking; but ſo clear, that one may palpably ſee the water or any heavy thing how and why it is mounted by turning.

LV. A double water-ſcrew, the innermoſt to mount the water, and the outermoſt for it to deſcend more in number of threads, and conſequently in quantity of water, though much ſhorter than the innermoſt ſcrew, by which the water aſcendeth, a moſt extraordinary help for the turning of the ſcrew to make the water riſe.

LVI. To provide and make that all the weights of the deſcending ſide of a wheel ſhall be perpetually further from the center, than thoſe of the mounting ſide, and yet equal in number and heft to the one ſide as the o-

ther. A moſt incredible thing, if not ſeen, but tried before the late King (of bleſſed memory) in the Tower, by my directions, two extraordinary Embaſſadors accompanying his Majeſty, and the Duke of Richmond and Duke Hamilton, with moſt of the court, attending him. The wheel was 14 feet over, and 40 weights of 50 pounds apiece. Sir William Balfour, then Lieutenant of the Tower, can juſtify it, with ſeveral others. They all ſaw, that no ſooner theſe great weights paſſed the diameter-line of the lower ſide, but they hung a foot further from the center, nor no ſooner paſſed the diameter, line of the upper ſide, but they hung a foot nearer. Be pleaſed to judge the conſequence.

LVII. An ebbing and flowing water-work in two veſſels, into either of

which the water ſtanding at a level, if a globe be caſt in, inſtead of riſing it preſently ebbeth, and ſo remaineth untill a like globe be caſt into the other veſſel, which the water is no ſooner ſenſible of, but that veſſel preſently ebbeth, and the other floweth, and ſo continueth ebbing and flowing untill one or both of the globes be taken out, working ſome little effect beſides its own motion, without the help of any man within ſight or hearing: but if either of the globes be taken out with ever ſo ſwift or eaſy a motion, at the very inſtant the ebbing and flowing ceaſeth; for if during the ebbing you take out the globe, the water of that veſſel preſently returneth to flow, and never ebbeth after, until the globe be returned into it, and then the motion beginneth as before.

LVIII. How to make a piſtol to diſcharge a dozen times with one loading, and without ſo much as once new priming requiſite, or to change it out of one hand into the other, or ſtop one's horſe.

LIX. Another way as faſt and effectual, but more proper for carabines.

LX. A way with a flaſk appropriated unto it, which will furniſh either piſtol or carabine with a dozen charges in three minutes time, to do the whole execution of a dozen ſhots as ſoon as one pleaſeth, proportionably.

LXI. A third way, and particular for muſquets, without taking them from their reſts to charge or prime, to a like execution, and as faſt as the flaſk, the muſquet containing but one charge at a time.

LXII. A way for a harquebuſs, a crock, or ſhip-muſquet, ſix upon a carriage, ſhooting with ſuch expedition, as without danger one may charge, level, and diſcharge them ſixty times in a minute of an hour, two or three together.

LXIII. A ſixth way, moſt excellent for ſackers, differing from the other yet as ſwift.

LXIV. A ſeventh, tried and approved before the late King (of ever bleſſed memory) and an hundred Lords and Commons, in a cannon of 8 inches half quarter, to ſhoot bullets of 64 pounds weight, and 24 pounds of powder, twenty times in ſix minutes; ſo clear from danger, that after all were diſcharged, a pound of butter did not melt being laid upon the cannon-breech, nor the green oil diſcoloured that was firſt anointed and uſ-

ed between the barrel thereof, and the engine, having never in it, nor within ſix feet, but once charge at a time.

LXV. A way that one man in the cabin may govern the whole ſide of ſhip-muſquets, to the number (if need require) of 2 or 3000 ſhots.

LXVI. A way that againſt ſeveral advenues to a fort or caſtle, one man may charge fifty cannons playing, and ſtopping when he pleaſeth, though out of ſight of the cannon.

LXVII A rare way likewiſe for muſquetoons faſtened to the pummel of the ſaddle, ſo that a common trooper cannot miſs to charge them with twenty or thirty bullets at a time even in full career.

'When firſt I gave my thoughts 'to make guns ſhoot often I thought 'there had been but one only exqui-

'ſite way inventible, yet by ſeveral 'trials and much charge I have per-'fectly tried all theſe.

LXVIII. An admirable and moſt forcible way to drive up water by fire, not by drawing or ſucking it upwards, for that muſt be as the philoſopher calleth it, *Intra ſphaeram activitatis*, which is but at ſuch a diſtance. But this way hath no bounder, if the veſſels be ſtrong enough; for I have taken a piece of a whole cannon, whereof the end was burſt, and filled it three quarters full of water, ſtopping and ſcrewing up the broken end; as alſo the touch-hole; and making a conſtant fire under it, within 24 hours it burſt and made a great crack: ſo that having a way to make my veſſels, ſo that they are ſtrengthened by the force within them, and the one to fill after the o-

ther, I have ſeen the water run like a conſtant fountain-ſtream forty feet high; one veſſel of water rarified by fire driveth up forty of cold water. And a man that tends the work is but to turn two cocks, that one veſſel of water being conſumed, another begins to force and re-fill with cold water and ſo ſucceſſively, the fire being tended and kept conſtant, which the ſelf-ſame perſon may likewiſe abundantly perform in the interim between the neceſſity of turning the ſaid cocks.

LXIX. A way how a little triangle ſcrewed key, not weighing a ſhilling, ſhall be capable and ſtrong enough to bolt and unbolt round about a great cheſt an hundred bolts through fifty ſtaples, two in each, with a direct contrary motion, and as many more from both ſides and ends,

and at the ſelf-ſame time ſhall faſten it to the place beyond a man's natural ſtrength to take it away: and in one and the ſame turn both locketh and openeth it.

LXX. A key with a roſe-turning pipe, and two roſes pierced through end ways the bit thereof, with ſeveral handſomely-contrived wards, which may likewiſe do the ſame effects.

LXXI. A key perfectly ſquare, with a ſcrew turning within it, and more conceited than any of the reſt, and no heavier than the triangle-ſcrewed key, and doth the ſame effects.

LXXII. An eſcutcheon to be placed before any of theſe locks with theſe properties.

I. The owner (though a woman) may with her delicate hand vary the ways of coming to open

the lock ten millions of times, beyond the knowledge of the ſmith that made it, or of me who invented it.

II. If a ſtranger open it, it ſetteth an alarm a-going, which the ſtranger cannot ſtop from running out; and beſides, though none ſhould be within hearing, yet it catcheth his hand, as a trap doth a fox; and though far from maiming him, yet it leaveth ſuch a mark behind it, as will diſcover him if ſuſpected: the eſcutcheon or lock plainly ſhewing what monies he hath taken out of the box to a farthing, and how many times opened ſince the owner had been in it.

LXXIII. A tranſmittable gallery over any ditch or breach in a town-

wall, with a blind and parapet cannon-proof.

LXXIV. A door, whereof the turning of a key, with the help and motion of the handle, makes the hinges to be of either ſide, and to open either inward or outward, as one is to enter or to go out, or to open in half.

LXXV. How a tape or ribbon-weaver may ſet down a whole diſcourſe, without knowing a letter, or interweaving any thing ſuſpicious of other ſecret than a new faſhioned ribbon.

LXXVI. How to write in the dark as ſtreight as by day or candle light.

LXXVII. How to make a man to fly; which I have tried with a little boy of ten years old in a barn,

from one end to the other, on an hay-mow.

LXXVIII. A watch to go conſtantly, and yet needs no other winding from the firſt ſetting on the cord or chain, unleſs it be broken, requiring no other care from one than to be now and then conſulted with concerning the hour of the day or night; and if it be laid by a week together, it will not err much, but the oftener looked upon, the more exact it ſheweth the time of the day or night.

LXXIX. A way to lock all the boxes of a cabinet, (though never ſo many) at one time, which were by particular keys appropriated to each lock opened ſeverally, and independent the one of the other, as much as concerneth the opening of them, and by theſe means cannot be left opened unawares.

LXXX. How to make a piſtol barrel no thicker than a ſhilling, and yet able to endure a muſket proof of powder and bullet.

LXXXI. A comb-conveyance carrying of letters without ſuſpicion, the head being opened with a needle-ſcrew drawing a ſpring towards them; the comb being made but after an uſual form carried in one's pocket.

LXXXII. A knife-ſpoon or fork in an uſual portable caſe, may have the like conveyances in their handles.

LXXXIII. A raſping-mill for harts horn, whereby a child may do the work of half a dozen men commonly taken up with that work.

LXXXIV. An inſtrument whereby perſons ignorant in arithmetic may perfectly obſerve numerations and ſubſtractions of all ſums and fractions.

LXXXV. A little ball made in

the ſhape of a plumb or pear, being dextrouſly conveyed or forced into a body's mouth, ſhall preſently ſhoot forth ſuch and ſo many bolts of each ſide and at both ends, as without the owner's key can neither be opened or filed off, being made of tempered ſteel, and as effectually locked as an iron cheſt.

LXXXVI. A chair made *a-la-mode*, and yet a ſtranger being perſuaded to ſit down in it, ſhall have immediately his arms and thighs lock'd up beyond his own power to looſen them.

LXXXVII. A braſs mold to caſt candles, in which a man may make 500 dozen in a day, and add an ingredient to the tallow which will make it cheaper, and yet ſo that the candles ſhall look whiter and laſt longer.

LXXXVIII. How to make a brazen or ſtone-head, in the midſt of a great field or garden, ſo artificial and natural, that though a man ſpeak never ſo ſoftly, and even whiſpers into the ear thereof, it will preſently open its mouth, and reſolve the queſtion in French, Latin, Welſh, Iriſh or Engliſh, in good terms, uttering it out of his mouth, and then ſhut it until the next queſtion be aſked.

LXXXIX. White ſilk knitted in the fingers of a pair of white gloves, and ſo contrived without ſuſpicion, that playing at Primero at cards, one may without clogging his memory keep reckoning of all ſixes, ſevens, and aces which he hath diſcarded.

XC. A moſt dextrous dicing box, with holes tranſparent, after the uſual faſhion, with a device ſo dextrous, that with a knock of it againſt the

table the four good dice are faſtened, and it looſeneth four falſe dice made fit for his purpoſe.

XCI. An artificial horſe with ſaddle and caparifons fit for running at the ring, on which a man being mounted, with his lance in his hand, he can at pleaſure make him ſtart, and ſwiftly to run his career, uſing the decent poſture with *bon grace*, may take the ring as handſomely, and running as ſwiftly as if he rode upon a barbe.

XCII. A ſcrew made like a water-ſcrew, but the bottom made of iron-plate, ſpade-wiſe, which at the ſide of a boat emptieth the mud of a pond, or raiſeth gravel.

XCIII. An engine whereby one man may take out of the water a ſhip of 500 tuns, ſo that it may be calked, trimmed, and repaired without need

of the uſual way of ſtocks, and as eaſily let it down again.

XCIV. A little engine portable in one's pocket, which placed to any door, without any noiſe but one crack, openeth any door or gate.

XCV. A double croſs-bow, neat, handſome and ſtrong, to ſhoot two arrows, either together, or one after the other, ſo immediately that a deer cannot run two ſteps, but, if he miſs of one arrow, he may be reach'd with the other, whether the deer run forward, ſideward, or ſtart backward.

XCVI. A way to make a ſea-bank ſo firm and geometrically ſtrong, ſo that a ſtream can have no power over it; excellent likewiſe to ſave the pillar of a bridge, being far cheaper and ſtronger than ſtone-walls.

XCVII. An inſtrument whereby an ignorant perſon may take any

thing in perſpective, as juſtly, and more than the ſkilfulleſt painter can do by his eye.

XCVIII. An engine ſo contrived, that working the *Primum mobile* forward or backward, upward or downward, circulary or corner-wiſe, to and fro, ſtreight, upright or downright, yet the pretended operation continueth, and advanceth none of the motions above-mentioned, hindering, much leſs ſtopping the other; but unanimouſly, and with harmony agreeing they all augment and contribute ſtrength unto the intended work and operation: and therefore I call this *A Semi-omnipotent Engine*, and do intend that a model thereof be buried with me.

XCIX. How to make one pound weight to raiſe an hundred as high as one pound falleth, and yet the

hundred pound deſcending doth what nothing leſs than one hundred pound can effect.

C. Upon ſo potent a help as theſe two laſt mentioned inventions a water-work is by many years experience and labour ſo advantageouſly by me contrived that a child's force bringeth up an hundred feet high an incredible quantity of water, even two feet diameter, ſo naturally, that the work will not be heard even into the next room; and with ſo great eaſe and geometrical ſymmetry, that though it work day and night from one end of the year to the other, it will not require forty ſhillings reparation to the whole engine, nor hinder one days-work, and I may boldly call it the moſt ſtupendous work in the whole world; not only with little charge to drain all ſorts of mines, and furniſh

cities with water, though never ſo high ſeated, as well to keep them ſweet, running through ſeveral ſtreets, and ſo performing the work of ſcavengers, as well as furniſhing the inhabitants with ſufficient water for their private occaſions; but likewiſe ſupplying rivers with ſufficient to maintain and make them portable from town to town, and for the bettering of lands all the way it runs; with many more advantageous, and yet greater effects of profit, admiration and conſequence. So that deſervedly I deem this invention to crown my labours, to reward my expences, and make my thoughts acquieſce in way of further inventions: this making up the whole century, and preventing any further trouble to the reader for the preſent, meaning to leave to poſterity a book, wherein under each

of theſe heads the means to put in execution and viſible trial all and every of theſe inventions, with the ſhape and form of all things belonging to them, ſhall be printed by braſs-plates.

IN BONUM PUBLICUM,
ET
AD MAJOREM DEI
GLORIAM.

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FINIS.

DUD DUDLEY's

Metallum Martis.

OR, AN

Account of the difficulties he encountered, in erecting forges for making of iron, ſmelting it with pit-coal, ſea-coal, &c. in preference to charcoal, in 1654.

GLASGOW:
PRINTED BY A. DUNCAN & R. CHAPMAN.
M.DCC.XCIV.

TO THE

KING'S

MOST

SACRED MAJESTY.

MAY IT PLEASE YOUR MAJESTY.

ALL your kingdoms, dominions, and territories, being the happy ſubjects of your cares, are therefore the proper object of your view: Great Britain, O Great Britain! your principal iſland, here humbly preſents herſelf unto your royal preſence, view, and care; be pleaſed to interpret this her obſequiouſneſs, to be her duty; for ſince your Majeſty's ſafe return has already graciouſly deigned to view, and often to

review her ſhipping, ſtores, armories, ordonance, magazines, and trade: vouchſafe, great Sir, Great Britain your royal patronage, and once more, at ſome one hour or two, to grace it with your auſpicious ASPECT, in this mite, with all humility, preſented by

A faithful ſervant of your Sacred Father's, and a loyal ſufferer for your Sacred Majeſty; and by patent ſervant,

DUD DUDLEY.

TO THE

HONOURABLE HIS

MAJESTY's GREAT COUNCIL,

THE HIGH

COURT of PARLIAMENT.

YOUR predeceſſors, in former ages, had both ſerious conſiderations and conſultations before they made thoſe many wholeſome and good laws for the preſervation of wood and timber of this kingdom, i. 15, 22, Elizabeth, v. 27, Elizabeth, xix. 28, Elizabeth, iii. 5, in whoſe days, and ſince in King James's reign, ſhips in moſt parts and rivers of this kingdom (Thames ex-

cepted) might have been built for 40s. per ton; but now they can hardly be built for treble the value, wood and timber is ſo much decayed; therefore men of war, trade of merchants, of fiſhing, of navigation unto the plantations, will decay, if not timely prevented, which is hoped will be one of your principal cares, ſeeing our enemies have carried timber from England, and the iron works have much exhauſted it. The prevention of ſo great a conſumption, almoſt incurable, firſt is, to put the wholeſome laws in execution. Secondly, not to permit timber to be exported. Thirdly, to animate, as King James did, and alſo Prince Henry, the making of iron in England, Scotland, and Wales, with pit-coal, ſea-coal, and peat: which if the author who had a patent for it had

not been oppoſed, after he had made much good iron with pit-coal, it had long ſince, by his inventions, been fully perfected. The fourth, is to ſtop all the exportation of pit-coal and ſea-coal, paying his Majeſty's duty, if the coal be in a fit place to make iron therewith. Fifthly, that the author, or his agents, may have power to preſerve many thouſand tons of pit-coal, which are annually deſtroyed for ever, in England, Scotland, and Wales, which are fit to make iron, and the author of this treatiſe has demonſtrated it, being moved with pity, ſeeing his native country decaying, humbly offers but his judgment, and leaves the grave conſideration thereof to your learned and moſt ſerious conſultations and actings: praying, that you may animate good things and new inventi-

ons, that may bring unto his ſacred Majeſty and all loyal ſubjects, ſafety, ſtrength, wealth and honour, by our ſhips and men of war, fiſhing, navigation, and merchandize, unto foreign nations; but more eſpecially to and from the territories of Great Britain, our North Indies, abounding in mines and minerals, that they that are of the honourable corporations of mines Royal, and batteries, or any others, would lay in a common or joint ſtock, fully to ſet the mines at work, by employing our idle and burthenſome ſupernumerary people therein. Iron, tin, lead, copper, quickſilver, ſilver and gold, beſides many other minerals and marcaſites, lapis calaminaris, antimony, maganes, &c. alſo many mineral earths and precious ſtones.

Did I call Great Britain our North

Indies? Give me leave to repeat a paſſage till further ſatisfaction, of King Joſina of Scotland, a great phyſician, philoſopher and herbaliſt, living before Chriſt 161 years, at which time two venerable philoſophers and prieſts paſſing from Portugal to Athens, their ſhip and company, and mariners, all periſhed at Roſs, they only ſaved. After refreſhing and good entertainment, the King deſired of them, what they underſtood by their ſcience of the nature of the ground of Scotland; after deliberate adviſement, ſaid, "there was more riches and profit "to be gotten, within the veins of "the earth in Scotland, than above, "for the wining of mines and me-"tals; they knew this by influence "of the Heavens;" this you may ſee in the Chronicles of Scotland.

My dear maſter, our ſacred Martyr, Charles the firſt, of ever bleſſed memory, did animate the author by granting him a patent in the 14th of his reign, for the making of iron, and melting, ſmelting, extracting, refining, and reducing all mines and metals, with pit-coal, ſea-coal, peat, and turf, which was extinct, and obſtructed by reaſon of the war, and had not this unnatural and unparalleled war been, his late ſacred Majeſty himſelf had ſet at work many of his mines, and much good had been produced to Great Britain before this time.

At preſent the author is in good hope, and inceſſantly prays, that the mines be ſet at work in his days, by the honourable corporation of Mines Royal; for he verily believeth the time to be near when the

Omnipotent God, before he judges the world in fire, will ſhew his Omnipotency unto the nations, by revealing the wonderful and incredible things of nature, of which the learned do believe very many to be in the mineral kingdom, by working of mines, and fuſion of metals, gotten by honeſt labour, under ground, profitable to man and acceptable to God.

I might here ſpeak ſomewhat of ſuperior planets producing metal. Saturn, lead; Jupiter, tin; Mars, iron; but theſe abound in Great Britain; ſo do the inferior planets produce; Venus, copper; Mercury, quickſilver; Luna, ſilver; if God permits me health and leiſure from ſuits and troubles, not only to write of them, but alſo the manner of melting, extracting, refining, and reducing of

them with pit-coal, ſea-coal, peat, &c. In the interim, to let you know that Great Britain abounds with copper mines, much neglected, yet of great uſe for ordonance at land, and alſo at ſea; and for the making of braſs, with our lapis calaminaris, ſo much exported by the Dutch, which doth hinder our manufactories of braſs, and cauſe the Dutch and Swedes to raiſe the price of copper, ever ſince our ſmall loſs at ſea by the Dutch.

Mercury, (quickſilver,) is not wanting, but few artiſts have made any experiment of that mine in this kingdom. Luna, (ſilver,) doth abound in Great Britain, eſpecially a very rich vein, rake or fibre thereof, was wrought at Binny hills, near Linlithgow in Scotland, in the author's days; ſome part of which he hath, is mal-

leable ſilver, in the ore or mine, yet neglected; and ſo are many of our richeſt mines in England, Wales, &c. The cauſe is conceived to be the want of general and joint ſtock, for the employing our idle people, in getting and working of copper and ſilver mines.

Of the planet Sol, (gold,) I may not be ſilent, whoſe golden, glorious, pure, ſulphureous, piercing ſpirit communicating his virtue mineral unto all things, in mineral kingdom, as well as to the animal and vegetable kingdom; whoſe pure influence producing gold, cauſed the poor indigent people of Scotland, which the author did ſee, anno 1637, at Shortlough, ſix men to dig and carry with wheelbarrows the common earth or mould unto rivulets remote, out of which thoſe men did waſh gold grains, as

good as in the ſand of the rivers, in which rivers many have gotten gold, and ſeen grains of Sol, near one ounce weight, both in the Lowlands, and in the Highlands. Alſo he hath ſeen gold gotten in England, but not ſo plentifully as in Scotland, for Sir James Hope, anno 1654, brought from Scotland bags of gold grains unto Cromwell; ſome of which grains were very large, and as fine as any gold in the world that is in mines; thus I came to ſee the bags, taking a view of the Lowlands and Highlands of Scotland, anno 1637, in which year I ſpent the whole ſummer, (in opening of mines and making of diſcoveries) was at Sir James Hope's lead hills, near which I got gold; and he coming to London employed Capt. David Acheſon, a refiner whom I met with in Scotland, anno

1637 to find me out. When I came unto Sir James Hope's dwelling in Whitehall, he produced the bags unto me, and poured the gold out upon a board, in which was one large piece of gold; which had to it adjoining a large piece of white ſpar, very tranſparent, which Capt. David Acheſon, yet living at Edinburgh, ſaw; but I would never act with Sir James Hope, hoping of theſe times to ſee good things acted; for I believe God is about to reveal many of his ſecrets unto his Iſrael in this latter age, which made me not anſwer the letter of Sir James Hope, as followeth:

Edinburgh, 26th June, 1654.

"SIR,

"IF I had found the opportunity "before my parting, I purpoſed "to have been a ſuitor to you, and

" I perſuade myſelf you are ſo kind
" and generouſly diſpoſed, that you
" would have anſwered my deſire,
" and therefore alſo even at this diſ-
" tance, adventure to offer it: and
" it is, that you would confer upon
" me one breviate of your journey
" through the north of Scotland, as
" to the diſcovery of minerals. Upon
" ſome account, and at firſt view,
" this may ſeem as unreaſonable of
" me deſired, as improbable that you
" ſhould grant it: but the circum-
" ſtances of time and perſons conſi-
" dered, I am not altogether out of
" hope of it: only I ſhall ſay, if you
" condeſcend to me in this, though
" it be more in ſatisfaction to my cu-
" rioſity, than for any deſign I have
" upon the matter; yet you ſhall ſin-
" gularly oblige me to endeavour, and
" be ready as opportunity ſhall offer,

" to expreſs my thankfulneſs in
" what way you will preſcribe, that
" is in the power of
" Your very affectionate brother,
" JAMES HOPE."

This Sir James Hope was a Judge at the city of Edinburgh, and by Cromwell made Lord-Marſhall of Scotland.

My hope now is, that the honourable and ingenious corporation of the mines-royal, will ſet the mines at work, that my inventions, in which I have ſpent much time and charge, in melting, ſmelting, extracting, re-refining, and reducing of mines and metals, with pit-coal, ſea-coal, and peats, and have made with the ſame fuel many hundred tons of good merchantable iron, into caſt works and bars; may by the invention he en-

joyed according to the Act of Parliament, 21. Jacob. ſeeing the author can make it appear he hath been much obſtructed by law ſuits and the wars hitherto; deſires that his talent of undoubted truths (may not be buried) for the general good, but be brought to light after all the ſad ſufferings of the author, whereby he may add unto his new inventions, what he conceives fit to be done, that not only this ſo exhauſted kingdom may enjoy the benefit thereof, but alſo Scotland and Wales, which abound with coals, iron ſtone, and mines of all ſorts, minerals, and precious ſtones, &c.

Yet from England's granary, Scotland making no iron, and other territories, have their thorough ſupply, not only of iron, but of iron manufactories many, ſo hath Wales;

yet might Scotland and Wales not only ſupply themſelves, but ſupply his ſacred Majeſty's other territories, with iron, and iron wares, and ſteel: alſo, by iron and ſteel made with pit-coal, ſea-coal, and peat, and thereby be helpful unto themſelves and England, and all plantations of his Majeſty's on this ſide and beyond the Line.

TO THE

READER,

ESPECIALLY OF

ENGLAND, SCOTLAND,

AND

WALES.

THE injury and prejudice done unto me and to this iſland, my native country, for the making of iron, in caſt works and bars, with pit-coal, ſea-coal, peat and turf, and with the like fuel, to melt, extract, refine, and reduce all mines and metals, moved me, in the negligence of better wits and pens, to apologize for it in this enſuing treatiſe; and, believe me, reader, it was no private nor politic deſign in my invention, but

mere zeal becoming an honeſt man, *Patriæ, Parentibus, & Amicis*, that engaged me (after many others failed) in theſe inventions, for the general good and preſervation of wood and timber, which

Eque pauperibus, locupletibus eque
Eque neglectis pueris ſinu buſque nocebit.

Therefore it concerns his ſacred Majeſty, his High Court of Parliament, all his councils, mariners, merchants, royal and loyal ſubjects, (the deſtruction of wood and timber) to lay it to heart, and helping hands, upon fit occaſions, in theſe ſo laudable inventions, of making iron and melting of mines, and refining of them with pit-coal, ſea-coal, peat and turf; for the preſervation of wood and timber, for maintenance of navigation, men of war, the fiſhings, and merchants trade, which is the greateſt

ſtrength of Great Britain, and all other his Majeſty's kingdoms and territories, whoſe defence and offence, next under God, conſiſts by his ſacred Majeſty's aſſiſting care, and view of his men of war, ſhips, experienced mariners, merchants, ordnance of copper, braſs, and iron armories; ſteel and iron of all ſorts, both of bars, ſquares and caſt works, and which ought, and may be ſupplied from Scotland and Wales, by iron, copper, and braſs, and made there, with pit-coal, ſea-coal, and peats; and which abound there, and in England; alſo in Cornwall, Devonſhire, Somerſet, Glouceſter, Stafford, Darby, York, Lancaſter, Weſtmorland, Cumberland, are many copper mines; ſo is there in Pembroke, Carmarthen, Merioneth, and Denbyſhires; alſo there are very many rich

copper mines in very many places in Scotland, at Stirling, at Dumfad, and many other places, well known unto the author.

DUD DUDLEY.

DUD DUDLEY's

Metallum Martis.

THAT Great Britain, with her men of war, fleets and ſhipping have had in all ages, and in theſe latter ages, as great ſucceſs at ſeas, as any people whatſoever in the univerſe, cannot modeſtly be denied: in 1588 overthrowing that invincible Armada, ſo long a preparing; and ſince, other navies alſo, and whoſe Armadas, navies, arms, and men have been a terror to other nations; nay, her own grand magazines are the very granary from whence all his ſacred Majeſty's kingdoms, dominions, and territories, both in the Eaſt and Weſt Indies, on this ſide and beyond the Line, they have their whole and thorough ſupply of ſhip-

ping, men, arms, food, and raiment, and more than can be from any kingdom in the Chriſtian world.

Now, if wood and timber ſhould decay ſtill, and fail, the greateſt ſtrength of Great Britain, her ſhips, mariners, merchants, fiſhings, and his Majeſty's navies and men of war, for our defence and offence, would fail us, which before and ſince 1588 made his ſacred Majeſty's predeceſſors, Queen Elizabeth and her great Council, the then Parliament, to make laws for the preſervation of wood and timber, eſpecially near any navigable river, 1 Eliz 15. 27 Eliz. 19. 28 Eliz. 3. 5. 23 Eliz. 5. all which laws and others for the preſervation of wood and timber are ſtill in force, but not duly executed; alſo King James, his ſacred Majeſty's grandfather, and Prince Henry for the pre-

ſervation of wood and timber in this iſland, did, in the 9th year of his reign, grant his letters patent of privilege unto Simon Sturtevant, Eſq; for 31 years, for the making of iron with pit-coal and ſea-coal, for the preſervation of wood and timber of Great Britain, ſo greatly then conſumed by iron-works. This invention was by King James's command to be at large put in print, which book did contain near a quire of paper in quarto, called, Simon Sturtevant his Metallica. Anno 1612, May 22d, printed by George Eld. *cum privilegio.*

After Simon Sturtevant could not perform his making of iron with pit-coal or ſea-coal, according unto his engagement, King James and Prince Henry cauſed him to render up his patent, and a new patent was granted to John Ravenſon, Eſq; who alſo-

was enjoined to write a book of his inventions, called Ravenſon's Metallica, printed for Thomas Thorp, *cum privilegio*, May 15th, Anno 1613. After John Ravenſon, Eſq; had often failed with his inventions and great undertakings —— Gombleton, Eſq; a ſervant of Queen Ann's, undertook (by patent) to perform this invention of making of iron with pit-coal and ſea-coal; but he being as confident of his inventions as others, did erect at Lambeth, which the author viewed; and —— Gombleton, Eſq; failing, the learned and ingenious Dr. Jarden of Bath, the author's acquaintance, and ſundry others, obtained patents for the making of iron and melting of mines with pit-coal and ſea-coal, for the preſervation of wood and timber, all which inventions, and endeavours to effect and perfect the

ſaid works, has been by many heretofore well known to have worthily attempted the ſaid invention, although with fruitleſs ſucceſs, having ſeen many of their failings, I held it my duty to endeavour if it was poſſible to effect and perfect ſo laudable and beneficial, and alſo ſo much deſired inventions, as the making of iron into caſt works and bars, and alſo the melting, refining, extracting, reducing all ſorts of mines, minerals, and metals, with pit-coal, ſea-coal, peat and turf, for the preſervation of wood and timber, ſo much exhauſted by iron-works of late. Having former knowlege and delight in iron-works of my father's, when I was but a youth, afterwards at 20 years old was I fetched from Oxford, then of Baliol College, Anno 1619, to look and manage three iron-works of my father's,

one furnace and two forges, in the chace of Penſent in Worceſterſhire; but wood and charcoal growing then ſcant, and pit-coal in great quantities abounding near the furnace, did induce me to alter my furnace, and to attempt, by my new invention, the making of iron with pit-coal, aſſuring myſelf in my inventions the loſs to me would not be greater than others, nor ſo great although my ſucceſs ſhould prove fruitleſs; but I found ſuch ſucceſs at firſt trial that animated me; for, at my firſt trial or blaſt, I made iron to profit with pit-coal, *facere, eſt addere inventione.*

After I had made a ſecond blaſt and trial, the feaſibility of making iron with pit-coal and ſea-coal I found by my new invention to be good and profitable, but the quantity did not exceed three tons per week. After I

had brought my inventions unto ſome perfection, I doubted not in the future to have advanced my invention to quantity alſo.

Immediately after my ſecond trial, I wrote unto my father what I had done, and withal deſired him to obtain a patent for it from King James of bleſſed memory; the anſwer to which letter I ſhall inſert, only to ſhew the forwardneſs of King James in this his much animating invention, as he did with Simon Sturtevant, John Ravenſon, and Dr. Jarden and others, the letter is as follows:

Son Dudley,

THE King's Majeſty being at Newmarket, I ſent Parkes there on Saturday, to ſome friends of mine to move the King's Majeſty for my patent; who coming Sunday morning,

the afternoon, his Majeſty ſent a warrant to Maſter Attorney to diſpatch my patent; for the which I am infinitely obliged unto his Majeſty, that it pleaſed him, of his grace and favour, to diſpatch it ſo ſoon. I have been this night with Maſter Attorney, who will make haſte for me. God bleſs you, and commend me to all my friends.

Your loving father,
EDWARD DUDLEY.

March, 10*th* 1619.

This Richard Parkes, or Parkhouſe, Eſq; in the letter before mentioned, was the author's brother-in-law, who did, about one year after the patent was granted, carry for the author much good merchantable iron into the Tower, by King James's command, to be tried by all artiſts,

and they did very much approve of the iron. The ſaid Richard Parkhouſe, had a fowling gun made of pit-caol-iron, with his name gilt upon the gun, which gun was taken from him by Colonel Leviſon, Governor of Dudley caſtle, and never reſtored.

The ſaid Richard Parkhouſe's ſon, my nephew, Edward Parkhouſe, the 5th of January, 1645, preſſed me much to put pen to paper to ſhew what I had done in the invention of making iron with pit-coal and ſea-coal, not unknown unto this country, and to my brother Falcott, Eſq; and to my nephew, Parkhouſe, Eſq; and to my kinſman Mr. Dingley, to whom I intend to leave the ſubject of my inventions; notwithſtanding all my ſad ſufferings, from time to time, this forty years, in the inventions, my ſuffer-

ings in the war, and my eſtate ſold for my loyalty; and alſo my ſad ſufferings and obſtructions, ſince his ſacred Majeſty's happy reſtoration many ways; and alſo upon ſundry and many references to the Author's very great charge, pains, and time ſpent, of four years in his aged days, for the general good, by his invention for the preſervation of wood and timber of Great Britain.

Now let me ſhew ſome reaſons that induced me to undertake theſe inventions, after the many failings of others, well knowing, that within 10 miles of Dudley caſtle, there be near 20,000 ſmiths of all ſorts, and many iron-works, at that time, within that circle, decayed for want of wood, (yet formerly a mighty woodland country.)

Secondly, the Lord Dudley's woods

and works decayed, but pit-coal and iron-ſtone, or mines abounding upon his lands, but of little uſe.

Thirdly, Becauſe moſt of the coal-mines in theſe parts, as well as upon the Lord Dudley's lands, are coals, ten, eleven, and twelve yards thick, the top of the uppermoſt coal, or vein, gotten upon the ſuperficies of this globe or earth, in open works.

Fourthly, Under this great thickneſs of coal is very many ſorts of iron-ſtone-mines, in the earth, clay, or ſtone-earth like buts, in all four yards thick; alſo, under theſe iron-mines is ſeveral yards thick of coals, but of theſe in another place more convenient.

Fifthly, Knowing that when the colliers are forced to ſink pits, for getting of ten yards thick or more, that be gotten under the ground, be-

ing ſmall, are of little or no uſe in that inland country, nor is it worth the drawing out of the pits, unleſs it might be made uſe of by making of iron therewith into caſt works or bars.

Sixthly, Then knowing that if there could be any uſe made of the ſmall coals, that are of little uſe, then would they be drawn out of pits, which coals produce oftentimes great prejudice unto the owners of works, and the work itſelf, and alſo unto the colliers, who caſting of the ſmall coals together, which compelling neceſſity enforcing the colliers ſo to do, for two cauſes; one is to raiſe them to cut down the ten yards thickneſs of coals, drawing only the bigger ſort of coal, not regarding the leſſer or ſmall coal, which will bring no money, ſaying, " he that liveth long-

eſt let him fetch fire further." Next, theſe colliers muſt caſt theſe coals, or ſlack-droſs out of their ways, which ſulphureous ſmall coal, and crouded moiſt ſlack, heat naturally, and kindle in the middle of thoſe great heaps; often ſets the coalworks on fire, and flaming out of the pits, continue burning like Ætna in Sicily, or Hecla in Iceland. Yet, when theſe looſe ſulphureous compoſts of coal and ſlack, being conſumed in proceſs of time, the fire decays; yet notwithſtanding the fire hath continued in ſome pits many years, yet colliers have gotten coals again, in thoſe ſame pits, the fire not penetrating the ſolid and firm wall of coals, becauſe, *pabulum ignis eſt aer*, the air could not penetrate, but paſs by it in the looſe coal and ſlack; for coming into theſe pits afterwards, I beheld

the very blows of pikes or tools that got the coals there formerly. Alſo, from theſe ſulphureous heaps, mixed with iron-ſtone, (for out of many of the ſame pits is gotten much iron-ſtone, or mines) the fires heating vaſt quantities of water, paſſing through theſe ſoughs or adets, becometh hot as the bath at Bath, and more healing and ſovereign even for old ulcers and ſores; but becauſe many of theſe baths do proceed not only from common ſulphur, and vitriol of Mars, but alſo from Solar ſulphur in this iron-ſtone.

I hope *filii artis* will excuſe my digreſſion from the making of iron, with pit-coal or ſea-coal. There was ſo great a flood, by rain, called to this day the great May-day-flood, that it not only ruined the author's iron-works and inventions, but alſo many

other men's iron-works and inventions; and at a market-town, called Stourbridge in *Comitate Wigare*, although the author ſent with ſpeed to ſave the people from drowning, one reſolute man was carried from the bridge there, in the day time, and the nether part of the town was ſo deep in water, that the people had much ado to preſerve their lives, in the uppermoſt rooms of their houſes.

My ironworks and inventions thus demoliſhed, to the joy of many ironmaſters, whoſe works eſcaped the flood, and who had often diſparaged the author's inventions, becauſe the author ſold good iron cheaper than they could afford it, and which induced many of the ironmaſters to complain unto King James, averring that the iron was not merchantable. As ſoon as the author had repaired his

works and inventions (to his no ſmall charge) they ſo far prevailed with King James, that the author was commanded with all ſpeed poſſible, to ſend all ſorts of bar iron up to the Tower of London, fit for making of muſquets, carabines, and iron for bolts, fit for ſhipping; which iron being ſo tried, by artiſts or ſmiths, that the iron-maſters and iron-mongers were all ſilenced until 21ſt of King James. At the then Parliament all monopolies were made null, and diverſe of the iron-maſters endeavouring to bring the invention of making iron with pit-coal, ſea-coal, peat and turf, within the compaſs of a monopoly; but the Lord Dudley and the author did prevail, yet the patent was limited to continue but for 14 years; after which act, the author went on with his invention chearfully, and

made annually great ſtore of iron, good and merchantable, and ſold unto diverſe men yet living, at 12l. per ton. I alſo made all ſorts of caſt iron wares, as brewing ciſterns, pots, mortars, better and cheaper than any yet were made in theſe nations with charcoal; ſome of which are extant to be ſeen by any man (at the author's houſe, in the city of Worceſter) that deſires to be ſatisfied of the truth of the invention.

Afterwards, the author was ouſted of his works and inventions, before mentioned, by the iron-maſters and others wrongfully, over long to relate: yet being unwilling his inventions (having undergone much charge and pains therein) ſhould fall to the ground, and be buried in him, made him to ſet forward his invention again, at a furnace called Himley fur-

nace, in the county of Stafford, where he made much iron, with pit-coal; but wanting a forge to make it into bars, was conſtrained, for want of ſtock, to ſell the pig-iron unto the charcoal iron-maſters, who did him much prejudice, not only in detaining his ſtock, but alſo diſparaging his iron. Himley furnace being rented out unto charcoal-iron-maſters, the author erected a new large furnace on purpoſe, 27 feet ſquare, all of ſtone, for his new invention, at a place called Haſco Bridge, in the pariſh of Sedgley and county of Stafford; the bellows of which furnace were larger than ordinary bellows are, in which work he made 7 tons of iron per week, the greateſt quantity of pit-coal-iron that ever yet was made in Great Britain; near which furnace the author diſcovered many

new coal mines, 10 yards thick, and an iron mine under it, according to other coal-works, which coal-works being brought unto perfection, the author was, by force, thrown out of them, and the bellows of his furnace and invention, by riotous perſons, cut in pieces, to his no ſmall prejudice, and loſs of his invention of making of iron with pit-coal, ſea-coal, &c. So that being with law ſuits and riots, wearied and diſabled to proſecute his art and invention, at preſent, even until the firſt patent was extinct: notwithſtanding the author his ſad ſufferings, impriſonments wrongfully, for ſeveral thouſand pounds in the Compter, London, yet did obtain a new patent, dated the 2d of May, in the 14 Caroli I. of ever bleſſed memory, not only for the making of iron into caſt works and bars, but al-

ſo for the melting, extracting, refining, and reducing of all mines, minerals, and metals, with pit-coal, ſea-coal, peat, and turf, for the preſervation of wood and timber of this iſland; into which patent the author, for the better ſupport and management of his invention, ſo much oppoſed formerly at the Court, at the Parliament, and at the Law, took in David Ramſay, Eſq; reſident at the Court, Sir George Horſey at the Parliament, Roger Foulke, Eſq; a Counſellor of the Temple, and an ingenious man; and alſo an ironmaſter, my neighbour, and one who did well know my former ſufferings, and what I had done in the inventions of the making of iron with pit-coal, &c.

All which ſaid patentees, articled, the 11th of June following, they grant not only to pay the author all the

charges of paſſing the patent laid down by him, but alſo to lay in a common and joint ſtock, each man of the four, one hundred pounds, and ſo, from time to time, what more ſtock any three of the patentees ſhould think fit to be laid in, for the making of iron into caſtworks, and bars, and likewiſe for the melting, extracting, refining, and reducing of all mines, minerals, and metals, with pit-coal, ſea-coal, peat and turf, which articles are yet extant.

Now, let me, without offence, inſert the oppoſition we all had, by means of powerful iron-maſters, with Sir Philibeard Vernat, a Dutchman, and Capt. Whitmore, who pretended much unto his late ſacred Majeſty, but performed not their undertaking, which cauſed the author and his partners thus to petition.

To the KING'S Moſt Excellent Majeſty.

The humble petition of Sir George Horſey, Knight, David Ramſay, Roger Foulke, and Dud Dudley, Eſqrs;

Humbly ſheweth,

"THat whereas your petitioners being called before the Right Honourable the Lord Keeper, by your Majeſty's appointment, touching the making of iron with pit-coal, ſea-coal, peat and turf, for which they have your Majeſty's patent; and ſeeing that Sir Philibeard Vernat, and Capt. Whitmore, who were not inventors, obtained a patent alſo for the ſame; yet before their patent granted, Sir Philibeard was ordered at Council Board, according to his great undertaking, to perfect his great undertaking and invention, within

two years; and there hath been near three years paſſed, and yet have made little or no iron, ſtill he oppoſeth your petitioners, and doth neither benefit himſelf, but hinders your Majeſty and the kingdom."

The reference unto the petition followeth:

At the Court at Greenwich, May 20th, 1638.

His Majeſty is pleaſed to refer this petition to Maſter Attorney and Maſter Solicitor General, to call the petitioners before them, and to compoſe the differences between them, (if they can) or otherwiſe, to certify his Majeſty their opinions therein.

Sir Sidney Montague was then maſter of the requeſts.

But Sir Philibeard Vernat, and Captain Whitmore never appeared a-

ny more for their inventions. Not long after the wars came on, and cauſed my partners to deſiſt; ſince which they are all dead, but the author, and his eſtate (for his loyalty unto his late ſacred Majeſty and maſter, as by additional act of Parliament may appear) was totally ſold.

Yet nevertheleſs I ſtill endeavoured not to bury my talent, took in two partners into my inventions, Walter Stephens of Briſtol, linen-draper, and John Stone, of the ſame city, merchant. After the author had begun to erect a new work for the inventions aforeſaid near Briſtol, 1651; and there we three partners had in ſtock near 700l. but they not only cunningly drew me into bond, entered upon my ſtock and work, unto this day detained it, but alſo did unjuſtly enter ſtaple actions in Briſtol

of great value againſt me, becauſe I was of the King's party, unto the great prejudice of my inventions and proceedings, my patent being then almoſt extinct, for which and my ſtock, am I forced to ſue them in Chancery.

In the interim of my proceedings, Cromwell and the then Parliament granted a patent, and an act of Parliament unto Captain Buck of Hampton-road, for the making of iron with pit-coal and ſea-coal. Cromwell and many of his officers were partners, as Major Wildman, and others, many Doctors of Phyſic and Merchants, who ſet up divers and ſundry works and furnaces, at a vaſt charge, in the foreſt of Dean, and after they had ſpent much in their invention and experiments, which was done in ſpacious wind furnaces, and alſo in pots

of glaſs-houſe clay; and failing afterwards, got unto them an ingenious glaſs-maker, Mr. Edward Dagney, an Italian, then living in Briſtol, who after he had made many pots for that purpoſe went with them into the foreſt of Dean, and built for the ſaid Captain Buck and his partners a new furnace, and made therein many and ſundry experiments and trials, for the making of iron with pit-coal and ſea-coal, &c. But he failing, and his pots being all broken, he did return to Briſtol fruſtrate of his expectation, but further promiſing to come again, and make more experiments, at which time, Mr. John Williams, Mr. Dagney's, maſter of the glaſs-houſe, was then drawn in to be a partner for 300l. depoſited, and moſt of it ſpent, the ſaid Williams and Dagney, hearing that the author had

knowledge in the making of iron, with pit-coal, ſea-coal, &c. they from Capt. Buck, and the other partners importuned the author, who was at that time in great danger by the Parliament (being a Colonel of the King's party) to go along with them into the foreſt of Dean, which he at that time durſt not deny; coming thither, I obſerved their manner of working, and found it impoſſible, that the ſaid Edward Dagney, by his invention, ſhould make any iron with pit-coal or ſea-coal in pots to profit. I continued with them till all their pots and inventions failed; at every dinner and ſupper, Capt. Buck, Capt. Robins, Dr. Ivie, Dr. Fowler, and others, would aſk the author, why he was ſo confident that iron in quantity could not be made by their new inventions? I found it a difficult thing

to diſſuade the partners from their way, ſo confident were they to perform the making of iron with pit-coal or ſea-coal to profit, that they deſired me to come again into the foreſt a ſecond time, to ſee it effected: but at that time I ſaw their failings alſo.

Yet neverthelefs Capt. Buck and his partners erected new works, at the city of Briſtol, in which they did fail as much as in their former inventions; but Major Wildman, more barbarous to me than a wild man, (although a miniſter) bought the author's eſtate, near 200l. per annum, intending to compel from the author his inventions of making of iron with pit-coal; but afterwards paſſed my eſtate unto two barbarous brokers of London, that pulled down the author's two manſion-houſes; ſold

500 timber trees off his land; and to this day are his houſes unrepaired.

Anno 1655, Capt. Buck and his partners, wearied of their invention, deſiſting, anno 1656, Capt. John Copley, from Cromwell, obtained another patent, for the making of iron with pit-coal and ſea-coal. He and his partners ſet up their works, at the coal-works near Briſtol, and endeavoured, by engineers aſſiſtance, to get his bellows to be blown at or near the pits of coal, with which engines the work could not be performed. But the author coming to ſee the ſaid works, and after many diſcourſes with Captain Copley, his former acquaintance, told him plainly, if his bellows would have been blown by theſe engines, yet I feared he could not make iron with pit-coal or ſea-coal; he ſeemed diſcontented,

whereupon, and without thoſe engines, I made his bellows to be blown feaſibly, as by the note under his hand appears. (The firſt note followeth.)

1656, December 30th.

Memorandum. The day and year above written, I, John Copley of London, Gent. do acknowledge, that after the expence of divers hundred pounds to Engineers, for the making of my bellows to blow for the making of iron, with pit-coal and ſea-coal, near Briſtol, and near the foreſt of Kingſwood, that Dud Dudley, Eſq; did perform the blowing of the ſaid bellows, at the work or pits aboveſaid, a very feaſible and plauſible way; that one man may blow them with pleaſure for the ſpace of an hour or two, and this I do acknowledge to be performed with a very ſmall charge,

and without any money paid to him for the ſaid invention.

JOHN COPLEY.

Capt. John Copley, thus failing in his inventions, anno 1657, he went into Ireland, and all men now deſiſting from the inventions of making of iron with pit-coal and ſea-coal; the author, anno 1660, being 61 years of age, and moved with pity, and ſeeing no man able to perform the maſtery of making of iron with pit-coal or ſea-coal, immediately upon his ſacred Majeſty's happy reſtoration, the ſame day he landed, petitioned that he might be reſtored to his place, and his patent obſtructed, revived for the making of iron with pit-coal, ſea-coal, peat, and turf, into caſt works and bars, and for the melting, extracting, refining, and reducing of all mines,

metals, and minerals, with pit-coal, ſea-coal, peat, and turf, which ſaid laudable invention, the author was and is unwilling ſhould fall to the ground, and die with him; neither is the myſtery or maſtery of the inventions effected, and perfected by any man, known to the author, in England, Scotland, or Wales, all which three abound with pit-coal or ſea-coal, and do overmuch furniſh other kingdoms, many with pit-coal and ſea-coal, when they might make far better uſe of it themſelves, eſpecially Scotland and Wales, both for the making of iron into caſt works and bars; and alſo, for the making of ſteel, and melting, extracting, and refining of lead, tin, iron, gold, copper, quickſilver, and ſilver with pit-coal and ſea-coal.

I ſhall not trouble you with the pe-

tition, or my reaſons and deſires that were annexed to it, for the making of iron and melting of mines, &c. with pit-coal, &c. they are over long to relate, only the reference to them is thus; after my firſt petition was loſt, I petitioned again.

At the Court at Whitehall, June 22d, 1663.

His Majeſty is graciouſly pleaſed to refer the conſideration of this petition to Maſter Attorney and Solicitor General, or to either of them, together with the petitioners reaſons and deſires hereunto annexed, and they, or either of them, are to inform, and certify his Majeſty, what they or either of them, in their judgments reſpectively, conceive fit for his Majeſty to do, concerning the petitioner's humble requeſt, and then his Majeſty

will declare his further pleaſure.

Robert Manners, maſter of requeſts.

After Maſter Attorney and Solicitor General would do nothing upon the reference, the author petitioned his ſacred Majeſty, ſitting at the Council-board, for the renewing of his patent, for making of iron and melting of mines, with pit-coal, ſea-coal, &c. often obſtructed; the reference to which followeth.

Whitehall, July 25th, 1660.

" Upon reading a petition this day " at the board, being the ſame *in ter-* " *minis* with this above written, " which his Majeſty was graciouſly " pleaſed, by a reference, under the " hand of Dr. Maſon, one of the " maſters of the requeſts, to refer to " the conſideration of Maſter Attor-

" ney and Maſter Solicitor General,
" together with the petitioners rea-
" ſons and deſires, thereunto annex-
" ed, to the conſideration of the
" Lords, and other Commiſſioners of
" the Treaſury, who upon examina-
" tion of the particulars, are to give
" ſuch order thereupon, as they ſhall
" find moſt proper for his Majeſty's
" ſervice."

The author, during the Lords Commiſſioners their time, could get no order upon his reference, but his petition was left with the now Right Honourable the Lord Treaſurer, to take or grant further order therein, but the author hath gotten hitherto no order.

Therefore compelling neceſſity doth conſtrain (having proſecuted his petition hitherto) him to deſiſt from his inventions, in which he hath taken more pains, care and charge,

than any man, to perfect his new invention in these kingdoms, although he hath not as yet so fully perfected or raised his invention to the quantity of charcoal-iron-furnaces, yet the author's quantity being but seven tons per week, together with the quality of his iron made with pit-coal and sea-coal, hath the most eminent triplicity of iron, of all that can be desired in any new invention.

1. More sufficient. 2. More cheap. 3. More excellent.

Upon which triplicity, the author might enlarge himself, but shall not be tedious, only give me leave to mention that there be three sorts of cast-iron.

1. The first is gray iron.

2. The second sort is called motley iron, of which one part of the sows or

pigs is gray, the other part is white intermixed.

3. The third ſort is called white iron, this is almoſt as white as bell-metal, but in the furnace is leaſt fined, and the moſt terreſtrial. Of the three, the motley iron is ſomewhat more fined; but the gray iron is moſt fined, and more ſufficient to make bar-iron with; and tough iron, to make ordnance, or any caſt veſſels, being more fined in the furnace, and more malleable and tough, than the other two ſorts before mentioned, and of this ſort is the iron made with pit-coal, ſea-coal, for the moſt part, and therefore more ſufficiently to be preferred.

2. Cheaper iron there cannot be made, for the author did ſell pig or caſt iron made with pit-coal at 4l. per ton, many tons in the 20th year of

King James, with good profit; of late charcoal-iron hath been ſold at 6l. yea, at 7l. per ton, hath much been ſold of late years.

Alſo the author did ſell bar-iron, good and merchantable, at 12l. per ton and under, but ſince, bar-iron hath been ſold for moſt part ever ſince at 15l. 16l. 17l. and 18l. per ton, by charcoal iron-maſters.

3. More excellent for divers reaſons, and principally, being the means whereby the wood and timber of this iſland almoſt exhauſted, may be timely preſerved yet, and vegetate and grow again unto its former wonted cheapneſs, for the maintenance of navigation, which is the greateſt ſtrength of Great Britain, whoſe defence and offence, for all the territories that belong unto it, next under God and his vice-gerent, our ſacred

Majeſty's cares, conſiſts moſt of ſhipping, men of war, experienced mariners, ordnances, ammunition and ſtores; the ordnance made therewith will be more gray and tough, therefore more ſerviceable at ſea and land, and the bar-iron will wall, rivet, and hold better than moſt commonly charcoal-iron.

2. More excellent, not only in reſpect the invention of making of iron with pit-coal and ſea-coal, will preſerve wood and timber of Great Britain, ſo greatly conſumed by iron-works of late.

But alſo in reſpect, this my invention will preſerve many millions of tons of ſmall coals in Great Britain, which will be loſt in time to come, as formerly they were; for within ten miles of Dudley Caſtle is annually conſumed four or five thouſand tons

at leaſt of ſmall pit-coal, and have been ſo conſumed, time out of mind under ground, fit to have made pit-iron with, which coals are, and (unleſs iron be made therewith) will be for ever totally and for ever annually loſt: if four or five thouſand tons of coal be conſumed within ten miles compaſs, what coal is thus conſumed in all England, Scotland, and Wales? which is no good huſbandry for Great Britain, *hinc illæ lacrimæ*, that our timber is exhauſted.

Muſt I be ſtill oppoſed, and never enjoy my inventions, nor Great Britain the benefiter?

Muſt my patent be obſtructed in peace, as it was extinct by the wars?

And muſt not my patent, for the making of iron with pit-coal, be revived, but find enemies ſtill to oppoſe it?

How many thouſand tons of iron might have been made? but ſince my firſt invention, anno Jacob. 18. by my means with pit-coal and ſea-coal, (loſt) if I had not had enemies; and had not wood and timber been preſerved? But moſt men will aver, that it doth concern the author to demonſtrate the great loſs mentioned formerly of pit-coal annually.

It is thus: There is at leaſt within ten miles of the Caſtle of Dudley, twelve or fourteen coalworks, ſome in Worceſter, and ſome of them in the County of Stafford (now in work, and twice as many in that circuit not in work) each of which works get two thouſand tons of coal yearly, ſome get three, four, or five thouſand tons of coal yearly, and the uppermoſt or top meaſures of coals are ten, eleven, and ſome twelve yards thick; the

coals aſcending baſſating, or as the colliers term it, cropping up, even unto the ſurface of the earth; and there the colliers formerly got the coals, but where the coal is not deep, and but little earth upon the meaſures of coal, there the colliers rid off the earth, and dig the coals under their feet; theſe works are called foot-rids.

But of theſe works there are now but few, ſome of theſe ſmall coals, in theſe open works, the poor people did carry away, but paid nothing for them, in former times, termed the brain carriages.

But now, the colliers working more deep in theſe works, they are conſtrained to ſink pits, ſome of which pits are from eight unto twenty yards deep, and ſome are near 20 fathoms deep, which fathom contains two yards.

In theſe pits, after you have made or hit the uppermoſt meaſures of coal, and ſunk or dug through them, the colliers getting the nethermoſt part of the coals firſt, about two yards in height or more, and when they have wrought the crutes or ſtalls (as ſome colliers call them) as broad and as far underground as they think fit, they throw the ſmall coals (fit to make iron) out of their way on heaps, to raiſe them up ſo high to ſtand upon, that they may, with the working of their picks or maundrills over their heads, and at one end of the coals ſo far in as their tool will permit, and ſo high as their working cometh unto a parting in the meaſure of coal; the which coals, to the parting by ſelf-clogging and ponderous weight, fall often many tons of coals, many yards high, down at once;

with which fall, and the colliers breaking of the ſaid coals, many ſmall coals do ſo abound of no uſe, and fit for no ſale; that in getting of twenty thouſand tons of pit-coal, one half near is ſmall coal, not drawn out of the pits, but deſtroyed, left, and loſt; which ſmall coal, with the ſlack thrown moiſt together, (heat the ſooner) and by means of its ſulphureouſneſs fire in the pits, to no ſmall prejudice unto the owners of the works, and the workmen, beſides Great Britain's loſs, which coal might have made many thouſand tons of iron, and alſo have preſerved this iſland's wood and timber: I might here give you the names, and partly the nature of every meaſure, parting of each coal lying on upon each other; the three uppermoſt meaſures are called the white meaſures, for his white ar-

ſenical, ſalſaginous, and ſulphureous ſubſtance, which is in that coal. The next meaſure is the ſhoulder-coal, the toe-coal, the foot-coal, the yard-coal, the flipper-coal, the ſawyer-coal, and the friſly-coal; theſe laſt three coals are the beſt for the making of iron, yet other coals may be made uſe of.

I might give you other names of coals, but deſire not prolixity; yet muſt I tell you of a ſupernumerary number of ſmiths within ten miles of theſe coal-works, near 20,000, yet God of his infinite goodneſs (if we will but take notice of his goodneſs unto this nation) hath made this country a very granary for the ſupplying theſe men with iron, coal, and lime, made with coal, which hath much ſupplied theſe men with corn alſo of late, and from

theſe men, a great part, not only of this iſland, but alſo of his Majeſty's other kingdoms and territories with iron-wares, have their ſupply and wood in theſe parts almoſt exhauſted, although he were of late a mighty woodland country.

Now of the coals and iron-ſtone ſo abounding, we need not want iron as we do; for very many meaſures of iron-ſtone are placed together under the great ten yard thickneſs of coal, and upon another thickneſs of coal two yards thick not yet mentioned, called the bottom-coal or the heathen-coal, as if God had decreed the time when and how theſe ſmiths ſhould be ſupplied, and this country alſo with iron, and moſt eſpecially that this coal and iron-ſtone ſhould give the firſt and juſt occaſion for the invention of

making of iron with pit-coal, no place being ſo fit for the invention to be perfected in, than this country, for the general good; where woods did formerly abound in foreſts, chaſes, parks, and woods, but exhauſted in theſe parts.

Now for the names of the iron-ſtone, the firſt meaſure is called the black-row grains, lying in very black and hard earth.

The ſecond meaſure is the dun-row grains, lying in dun earth or clay.

The third meaſure is called the white-row grains, lying in very white earth or clay; under theſe three meaſures are ſundry other meaſures, and are called, firſt, the rider-ſtone; ſecondly, the cloud-ſtone; thirdly, the bottom-ſtone; fourthly, the cannock or cannot-ſtone, which laſt

may well be ſo called (although all the other meaſures be very good) yet this ſtone is ſo ſulphureous and terreſtrial, not fit to make iron; becauſe the iron made thereof is, very red-ſhare, whichis, thatif a workman ſhould draw or forge out a ſhare mould, fit for a plough in that red-heat, it would crack and not be fit for the uſe of the huſbandman's plough or ſhare. I may take occaſion here to ſpeak of the nature of cold-ſhare-iron, which is ſo brittle, if made of the grain ore or iron-ſtone, would be almoſt as brittle as ſome Regulus Antimony made with iron, for with one ſmall blow over an anvil you may break the biggeſt bar, that is, if it be perfect cold-ſhare-iron; nay, the plough-man often breaks his plough-ſhare point off, if it e bmade of cold-ſhare-iron.

But perfect tough malleable iron will not break feasibly in hot, heat, or cold, as cold-share will, or red hot, as sulphureous veneriated red-share-iron will, but yet tough enough when it is cold; all which aforesaid qualities of iron, the author very well knoweth how to mend their natures, by fining or setting the finery less transhaw, more borrow, which are terms of art, and by altering and pitching the works and plates, the fore spirit-plate, the teuiron-bottom, back and breast, or fore-plate by altering of which much may be done, if the work be set transhaw and transiring from the blast the iron is more cold-share, less fined, more to the master's profit; less profitable to him that makes it into manufactorage, and less profitable to him that useth it; but the iron made in a burrow-work becometh more tough

and ſerviceable, yet the nature of all iron-ſtone is to be conſidered both in the furnace and in the finery, that the ſulphureous arſenial and veneriating qualities which are oftentimes in iron-ſtone, be made to ſeparate in both the works from the fixed and fixing bodies of iron, whoſe fiery quality is ſuch that he will ſooner ſelf calcine than ſeparate from any ſulphureous veneriating quality.

No man I hope need to be offended at any terms of art, it hath been always lawful for authors of new arts and inventions at their own pleaſure to give names to their new inventions and arts, every tradeſman is allowed it in his myſtery.

But the author hath as much as he could avoided the terms of art that Simon Sturtevant and others have uſed which are very many: on-

ly the author hath given you the common names and terms (for the moſt part) which are ſo common among forge-men and founders, as is nothing more common, but kept ſecret among them, and a myſtery not yet known, but unto very few owners of iron-works; nay, I have not yet troubled your memory with any of the founder terms, of but making his hearth, as the tinip-ſtones, the windwall-ſtones, the tuiron-ſtones, the bottom-ſtones, the back-ſtones and the boſhes, in the making and picking of which hearth, is much of the myſtery. I muſt confeſs, there is given unto ſome philoſophers and *filiis artis* ſome few terms how the ſulphureous, arſenical, bituminous, antimonial, venerial and other poiſonous qualities, either in the pit-coal, ſea-coal, or iron-ſtone, may be in part at the furnace

ſeparated, and not permitted to incorporate in the iron; and if it be incorporated, yet by fining at the forge, to fetch it out, alſo to melt, extract, refine, and reduce all mines, metals, and minerals, unto their ſpecies with pit-coal, ſea-coal, peat and turf, by ways not yet in uſe, which the author will make known hereafter, if God permit him health, time, and ſpace, or leave his knowledge unto his brother Aylmore Folliott, Eſq; his Nephew Parkſhouſe, Eſq; and to his kinſman, Mr. Francis Dingley, to declare unto this latter age of the world, in which God is pleaſed to manifeſt many of his ſecrets: *Qui vult ſecreta ſcire, ſecreta ſciat cuſtodire.*

Having ſuffered much, ever ſince the year 1618 unto this preſent, for the general good, as by the preceding diſcourſe appears, for the making of

iron with pit-coal, ſea-coal, peat and turf, for the preſervation of wood and timber of Great Britain, ſo much exhauſted, for the future prevention of which,

Is firſt, To permit the author to enjoy his patent and fully to perfect his ſaid inventions (obſtructed both in the reign of king James, and in the reign of his ſacred Majeſty king Charles the I. of ever bleſſed memory; and lately ſince his moſt ſacred Majeſty's happy reſtoration) who deſires nothing but to be animated with the patent revived according unto the ſtatute of 21 Jacob. for inventions.

Secondly, To impower the author, or any other agents to take care, that no pit-coal or ſea-coal be any ways wilfully deſtroyed under ground.

Thirdly, To put all former good

laws in execution, and to make others for the preſervation of wood and timber of theſe nations, eſpecially near navigable rivers or ſeas.

Fourthly, Seeing there goeth out of England, Scotland, and Wales, many thouſand tons annually of pit-coal, and ſea-coal, to furniſh France, and alſo the ſmiths thereof, Spain, Portugal and Flanders, and eſpecially the ſmiths thereof; the Low Countries and the ſmiths thereof, beſides the Hollanders, carry great quantities of our coals unto foreign parts, without which thoſe countries cannot ſubſiſt; now the author's deſire is, that where there is a conveniency of iron-ſtone or ore, the coals may not be tranſported, (paying his ſacred Majeſty's duty) until order from his Majeſty or his Privy Council.

Fifthly, That no pit-coal be ex-

ported, ſeeing that wood, fuel, and timber is decayed for buildings, and inſtead thereof brickmaking (formerly ſpending wood but now coals) is much in uſe; alſo, is glaſs now made with coal, but formerly were there many thouſand loads of wood full ſpent in making thereof, and the glaſs invention with pit-coal, was firſt effected near the author's dwelling.

Sixthly, Making of ſteel, brewings, making of copperas, allum, ſalt, caſting of braſs and copper, dyings, and many other works, were not many years ſince done altogether with the fuel of wood and charcoal; inſtead whereof pit-coal and ſea-coal are now uſed as effectually, and to far better uſe and purpoſe; beſides the preſervation of wood and timber.

Seventhly, That which is ſomewhat nearer the mark and invention, the

blackſmith forged all his iron with charcoal, and in ſome places where they are cheap, they continue this courſe ſtill, but ſmall pit-coal and ſea-coal, and alſo peat and turf hath and doth ſerve the turn as well and ſufficiently as charcoal.

Eighthly, That which is neareſt, and my perfect invention, and near the author's dwelling, called Green's Lodge, there are four forges: namely, Green's forge, Swin forge, Heath forge, and Cradley forge.

Which four forges have barred all, or moſt part, of their iron with pit-coal, ever ſince the author's firſt invention, 1618, which hath preſerved much wood: In theſe four, beſides many other forges, do the like; yet the author hath no benefit thereby to this preſent. Yet by this barring of iron with pit-coal 30,000 loads of

wood and more, have been preſerved for the general good, which otherwiſe muſt have been had and conſumed.

Simon Sturtevant in his *Metallica*, in the epiſtle to the reader, ſaith, that there was then, anno 12 Jacobi, in England, Scotland, Ireland, and Wales, 800 furnaces, forges, or iron-mills, making iron with charcoal; now we may ſuppoſe at leaſt 300 of theſe to be furnaces, and 500 to be forges; and each furnace making 15 tons per week of pig-iron, and work or blow but 40 weeks per annum: but ſome furnaces make 20 tons of pig-iron, and 2 loads of charcoal or thereabouts, go to the making of a ton of pig-iron: and 2 loads (or two cords) of wood at the leaſt, go to the making of a load of charcoal. Now what loads of wood or

charcoal is ſpent in Great Britain and Ireland annually? But in one furnace that makes 15 tons per week, of pig-iron for 40 weeks, I ſhall give you the table and leave you to judge of the reſt of the furnaces.

	charcoal.	*wood.*
15 tons per week ſpend, of	30 loads.	60 loads.
per annum, 40 weeks, ſpend	1200	2400

Alſo, for 1 forge, that makes 3 tons of bar-iron weekly for 50 weeks; but ſome forges make double my proportion, and ſpend to fine and bar out each,

3 loads of coals to each ton.

	charcoal.	*wood.*
3 tons per week,	9 loads,	18 loads.
per annum,	450 loads.	900 loads.

By theſe examples may you ſee, the vaſt quantities of charcoal or wood that the 300 furnaces, and the 500

forges ſpend, weekly or yearly. It being impoſſible after this rate for Great Britain or Ireland, to ſupply theſe her works with charcoal, in fining of iron at the fineries, may be permitted to uſe charcoal, and may be ſupplied with under wood.

Let us but look back unto the making of iron by our anceſtors, in foot-blaſts, or bloomeries, that was by men treading of the bellows, by which way they would make but one little lump, or bloom of iron in a day, not 100 weight, and that not fuſible nor fined, or malleable, until it were long burnt and wrought under hammers, and whoſe firſt ſlag-cynder or ſcorious, doth contain in it as much or more iron, than in that day the workman or bloomer got out, which ſlag, ſcorious, or cinder is by our founders at furnaces wrought again,

and found to contain much iron, and eaſier of fuſion than any ironſtone or mine of iron whatſoever, of which ſlag and cinder there is in many countries millions of tons and oaks growing upon them, very old and rotten. The next invention was to ſet up the bloomeries that went by water for the eaſe of the men treading the bellows, which being bigger and the water wheel cauſing a greater blaſt, did not only make a greater quantity of iron, but alſo extracted more iron out of the ſlag or cinder, and left them poorer of iron than the foot blaſts, ſo that the founders cannot melt them again, as they do the foot blaſt cynders to profit: yet theſe bloomeries by water (not altogether out of uſe) do make in one day but 200 lb. or thereabouts; neither is it fuſible or malleable but is unfined

until it be much burnt, and wrought a ſecond time in fire.

But ſome of the now going furnaces with charcoal, do make 2 or 3 tons of pig or caſt iron in 24 hours.

Therefore I do not wholly compute the vaſt quantities of charcoal and wood ſpent in theſe voragious works, which quantity of caſt iron, with pit-coal and ſea-coal, at one furnace, I deſire not, but am contented with half the proportion, which once I attained to before my bellows were riotouſly cut, that is, one ton in 24 hours; we need not a greater quantity, if the like quantity were made in furnaces in Scotland and Wales, which abounds with pit-coal and ſea-coal, as well as England; and our ſupernumerary ſmiths, founders, and forgemen, and other tradeſmen might be there employed, thereby to fur-

niſh his Majeſty's plantations, as well, if not better than England, where coals are far cheaper than in England.

Altho' vaſt quantities of coals do abound near the author's dwelling, yet 20,000 ſmiths or nailors at the leaſt, dwelling near theſe parts, and taking of 'prentices, have made their trade ſo bad, that many of them are ready to ſtarve and ſteal; ſo that it is wiſhed there were ſome courſes taken to mend their trade, employ them in other parts, or permit them not to take ſo many 'prentices, all which have great occaſions to uſe pit-coal, and had not theſe parts abounded with coal, it would have been a great deal worſe with them than it is, but of the coal, there is, nor will be any want, nor of iron-ſtone.

The manner of the coal veins or

meaſures in theſe parts and alſo of the meaſures of iron-ſtone or mines, how they ly, be, or increaſe, ſome mines be circular, ſome ſemicircular, ſome oval, ſome works almoſt in a direct line, and ſome works parts of a circle, as by the circle, it being only for a ſmall example to judge the mines by, may appear.

Cetera deſunt.

FINIS.


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